

# Accident Investigation Training

Human Factors

Photography

Witnesses

Records

Material Factors



Evidence

Analysis

Conclusions

Recommendations

Reporting



Naval Safety Center  
School Of Aviation Safety



**Presentation Time:** Approximately 1.5 hrs

**Note:** This presentation was created to be a “generic” guide to aviation organization accidents. As such, some topic discussions and examples may extend beyond the scope of your students’ investigation requirements. Discussion of all material, even if only briefly mentioned, is preferable to skipping over “extra” material because it provides students with additional insight, confidence, and resources to accomplish their own investigations.

Accident investigation is both an art and a science. Laboratory testing of materials, failure modes, sample analysis, etc. are scientific processes that provide useable data. But which items do you test? You may want to test everything, but even bringing an entire aircraft into a lab will not reveal much more than WHAT happened to the aircraft (e.g., it broke in a particular way) vice WHY it had an accident. A lab may also discover that a part failed due to fatigue. But why? Detective work is necessary to determine if the part was designed improperly, maintained improperly, or abused to either start the fatigue crack or allow it to go unnoticed, or worse, noticed but not corrected. For only those few options, there are countless additional WHYS. Was it designed or manufactured improperly because of poor staffing, organization, and QA at the manufacturer? Or was there a local maintenance problem with lighting, inadequate equipment, and time constraints? Was there a culture of indifference to quality and standards? Those answers are not found in a lab. The investigator must find the answer to the WHYS at the source. Interviews, photography, and an eye for detail are just the beginning.

This presentation will provide the beginning investigator with basic concepts and skills, as well as, heighten awareness on the necessity to conduct thorough investigations and report them adequately.

# Why Do We Investigate?



- **Identify hazards** (accident causal factors) and provide recommendations which will **prevent occurrence or recurrence**
- **Identify other hazards** that increased the level of injury/damage, but were not accident cause factors

## Why do we investigate?

To effectively discover the hazards that led to the accident and to prevent their recurrence in a future accident or incident. In the course of that investigation, additional hazards which increased damage and injury (inadequate crashworthy systems, system safeguards, rescue team response, etc.) can also be corrected to make future accidents less costly.

An investigator will most likely discover many other hazards during the course of an investigation which may have NOTHING to do with the accident. These additional hazards do NOT belong in the accident report, but they must also not be ignored. They should be addressed in a separate hazard report or corrected in some other fashion.

# **All Accidents are Preventable**

**Individual hazards are preventable.**

**Accidents are caused by multiple hazards.**

**Therefore, the elimination of hazards means that ALL ACCIDENTS are preventable.**

Important: All accident cause factors (hazards) are assumed to be controllable by humans. As such, they can be corrected, mitigated, and eliminated through recommended corrective actions. Is weather an exception? No, even though it is not directly controllable, it is manageable. Forecasting, weather radar, decisions to proceed in foul weather, etc. greatly reduce the hazards and ultimately lead to a reduction in accidents. If all hazards are controlled, then accidents could theoretically be eliminated.

NOTE: No accident is caused by a single hazard or factor, therefore, it is not very beneficial to categorize a factor as primary or contributory. A factor that seems to be less influential in one accident may be more influential in the next. Organizations tend to put more effort into correcting “primary” factors” and tend to delay corrections on “contributors”. Instead, an organization would be better served if it equally eliminated all factors (hazards) discovered to play a role in an accident.

## Purpose of YOUR Investigation?

### ➤ Punishment of personnel and lawsuit protection?

“Legal” approach

### ➤ Simply describe WHAT happened?

Historical use only because corrective actions need to address WHY something happened

### ➤ Prevent another accident or incident?

“Safety” approach (and “Legal”, if done correctly)

The purpose of a safety program should be to preserve human and material resources.

The objective of a safety program is to eliminate hazards, and if completely successful, the subsequent elimination of accidents.

An accident is a failure of an organization's overall safety program because the hazards were not discovered in time to prevent the accident.

Investigations are often conducted for both legal and safety reasons.

Legal: Claims, insurance, compensation, lawsuits...for employees, employers, and public

Safety: Prevention of future accidents and their associated physical, emotional, and material costs

Although used for different purposes, both the legal and safety investigation's primary outcome should be the prevention, or at least reduction, of future accidents. This requires not only knowing WHAT happened, but also WHY it happened. Separate the investigations if at all possible to eliminate a “blame and punish” perception of the safety investigation.

## **Effort vs Severity**

**Hazard Reports, Incident Reports, and  
Accident Reports....**

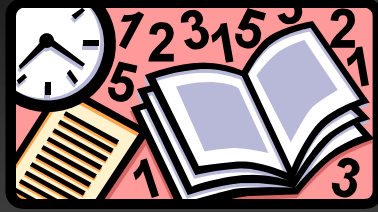
**ARE THERE MAJOR DIFFERENCES?**

- **Evidence**
- **Analysis**
- **Conclusions**
- **Recommendations**

Organizations tend to use more investigators and resources on major accidents. The number of hazards, the difficulty of analyzing the destroyed wreckage, etc. make this a logical choice. However, the process is the same no matter what the level of accident or incident. The investigator(s) must preserve and analyze the evidence and make meaningful recommendations to prevent future accidents. With this in mind, the investigations should be conducted in the same fashion and the level of investigator training should be identical.

# Investigation Requirements

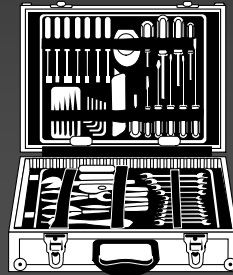
## Accident/Incident Plan



## Investigator In Charge



## Investigation Kit



- Teams?
- Individuals?
- External/Internal to organization?
- Safety, Maintenance, or others?

**Prior to an accident, an organization must determine who will conduct an investigation, establish guidelines on how it will be done, and provide the tools and authority necessary to conduct the task.**

**Accident/Incident Plan** Plans must be developed and practiced BEFORE an accident occurs. They must be easy to use and provide the necessary information to notify appropriate personnel, initiate the investigation, and document essential data (time of incident; location; etc.)

**Investigation Kit** To conduct an investigation, you will need a few simple tools. Accident kits should be compact and portable. The following items may be useful:

Surgical gloves (may be worn under work gloves) to prevent fuel, biological fluids, chemical contact; work gloves; writing tools; tape recorder; camera; tape measure; labels; accident/incident forms; knife; small hand tools; magnifying glass, etc.

The **Investigator in Charge (IIC)** must have the authority to conduct the investigation, acquire resources, and have access to an organization's leadership. The Investigator in Charge should be senior in authority to the person directly involved in the accident to eliminate influence over the reported outcome of the investigation. The IIC should also ensure that team members are well trained, equipped, and that they have no conflicting duties that take precedence over the investigative effort.

**Investigation Teams, etc:** Depending upon the level of accident and the size of an organization, safety investigations may be conducted by a team of personnel from various departments or by one or two individuals. Your organization must choose, plan, and train according to their requirements and abilities.

# Investigation Phases

- **Accident Response and Evidence Gathering**
- **Critical Examination**
- **Preliminary Analysis**
- **Validation of Findings**

## **Investigations, whether at a major crash site or at a single work station, should follow these basic phases:**

**Accident Response and Evidence Gathering:** The first few minutes (up to a couple of days at a major accident) are used to get a quick understanding of the magnitude of the accident and the response required to control conditions. Things to consider during this “walk through” include the safety of the site, whether the number of rescue and investigative personnel are sufficient, and conditions that may require additional support (legal claims, transportation, hazardous material cleanup, public affairs, etc.). After noting the “big picture” and ensuring that additional support is on the way (if needed), investigators can turn their attention to collecting and preserving evidence. Photographs, accident site sketches, recording switch/gauge information, note taking, witness identification/interviews, etc. occur at this time.

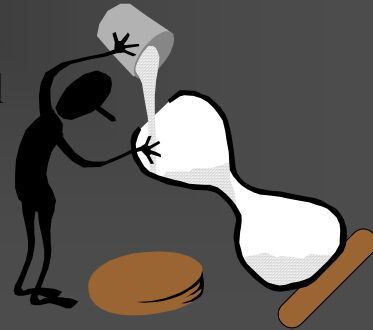
**Critical Examination:** After all the evidence is under your control, individual aircraft and equipment systems can be traced, evaluated, and possibly subjected to full engineering investigations. Data/documentation on equipment and personnel performance are scrutinized for errors and organizational shortcomings. This is not the time to focus on scenarios, that will be the next step. The investigator must first examine all evidence and extract as much information as possible. This methodical approach requires patience and an eye for discovery. You are examining puzzle pieces without knowing for sure what the final picture is going to be.

**Preliminary Analysis:** Investigators should ensure that ALL available evidence is gathered and analyzed FIRST, then you can formulate and test theories. Use the process of elimination to discount factors (this system works now, so it should have worked earlier), the maintainer was qualified (certifications, records, training, interviews), and extreme environmental factors were not a concern (indoor accident vice outside in freezing conditions)....

**Validation of Findings:** When the investigation team believes they have determined some likely factors, they should verify that they fit within all of the information known about the accident. Reexamine the entire accident sequence to ensure that your theory actually “works” and that it doesn’t contradict other evidence (you can mistakenly make ANY theory work if you ignore a little evidence here or there). Even if an investigation team can’t prove a theory is 100% correct, they can still test its acceptability by finding out if similar factors have previously caused accidents. This is one reason to have a detailed database of accidents.

# Initial Actions

- **Activate Plan**
- **Control the Site**
  - Security, Access, and Hazards
- **Notification of Personnel**
- **Get the BIG Picture**



## The INITIAL ACTIONS (first few hours) may be summarized, as follows:

Accident/Incident Plans should be well organized, useable, and accessible for immediate use. It should include telephone numbers, organizational duties, and forms for recording information. A well prepared Accident Plan will provide order during chaos. Its efficient implementation will save time and resources, as well as, prevent frustration among the respondents.

Control the Site: People can be injured and evidence lost or destroyed if prompt attention is not given to the controlling the accident site. Hazards should be secured. The area and equipment should be restricted to rescue and investigation personnel only.

Notification: Your organization must ensure that all necessary information is passed to those who can assist in the investigation, care for survivors and family members, respond to media inquiries, and help with the clean up efforts. Telephone numbers should be available for rapid response and all personnel should be trained on their collateral duties as assigned. Who gets called first ( i.e. Safety/QA/Supervisors/V.P.s/etc.)? Do you need to call a photographer, transportation company, or contracted investigator?

Get the Big Picture: This isn't the time to "guess" the accident cause factors. You must first determine the magnitude of the accident, investigation, and recovery effort. Is more than one organization involved, are there logistic problems to consider?

**It should be obvious that organizations need to plan for these actions BEFORE an accident occurs!**



# Accident Response and Evidence Gathering

- **Environment**
- **Components/Parts**
  - Is anything missing?
- **Site Photographs**
  - Controls and Switches
- **Rough Sketch/Diagram**

**After the initial accident response, the Investigator in Charge can begin to focus on the investigation of the accident. This requires diligent gathering of ALL available evidence.**

**Note:** Though many examples in this presentation discuss aircraft accidents, the same principles/tasks apply to accidents of any type (i.e. workplace environment, missing safeguards on tools, sketches and photographs of damaged machinery and accident areas, interviews, etc.).

Environment: Look at the ground, scrape/tire marks, trees, buildings, downed telephone lines, etc. for additional clues of how an aircraft/vehicle crashed or traveled through an area and the effect those “obstacles” might have on the accident equipment. Slow speed accidents into rocks or walls may yield more damage than a faster speed accident over smooth ground. However, high speed (jet) accidents have nearly equal damage by impacts in water, loose ground, or rocky areas because the differences in terrain compressibility are small compared to the destructive force of the aircraft at extreme velocity.

Components/Parts: The site should be examined to find the major equipment components to ensure that the site boundaries are adequate and to discover whether a part is missing (possibly indicating a reason for failure). **FIND ALL PARTS!**

Photographs: Take numerous pictures of the site, the equipment, the surrounding environment, and particularly the position of gauges and switches that may change during the movement of wreckage. Photography is the best way to “preserve” all of your evidence for later analysis.

Rough Sketch/Diagram: Drawing a simple picture of the accident site will be useful for team discussion over the next several hours and days. Sketches are useful immediately after completion, whereas a professional survey may take weeks.

(continued next slide)

# Accident Response and Evidence Gathering

- **Tag All Identifiable Parts**
  - Illustrated Parts Breakdown
  - Maintenance Personnel
- **Write Down Questions for Later Research**
- **Secure Records**
- **ID Witnesses**

(continued)

Tag All Identifiable Parts: Parts should be identified and tagged prior to movement. Maintenance/QA personnel should be selected for their ability to identify remnants of components. Parts manuals should be available for use at the site, if needed.

Write Down Questions for Later Research: Take notes and/or use a tape recorder to remember key observations and questions. No one can remember everything.

Secure Records All records that could possibly provide information (operational, maintenance, personnel records, etc.) should be secured immediately. Copies should be made of relevant information prior to returning the records. The concern is less on “cover ups” than it is on simple day-to-day “updating” of files and records. Your job is to acquire all evidence as it existed at the time of the accident, therefore, updated records may alter your findings.

ID Witnesses Witnesses should always be interviewed as quickly as possible, but the accident chain of events and prior personal interactions may necessitate interviews with people who have long since left an organization, are currently not available, etc. So ID all witnesses and arrange interviews as quickly as possible.

## **Tools to Obtain Evidence at the Site**

➤ **Photography**

➤ **Diagrams**

➤ **Witness Interviews**

Let us now look at three methods of accident site evidence gathering in more detail. We will discuss some important considerations in photography, site diagrams, and witness interviews.

(quickly go to next slide)

# Photography Considerations

## ➤ Experience

- Professional photographer
- Investigation team photographer

## ➤ Restrictions and Limitations

- B&W vs Color Film
- Commercial Developing
- Photo Control (Safety Use Only?)

## ➤ Cameras

- 35mm SLR with Zoom
- Instant
- Digital?
- Video

## ➤ Security Cameras/ Other Sources?



**Experience** It is of utmost importance that you pre-select a photographer. Professional photographers provide excellent services, but they may not be available when an accident occurs in the middle of the night or at a more remote area. Select an “in house” photographer if possible.

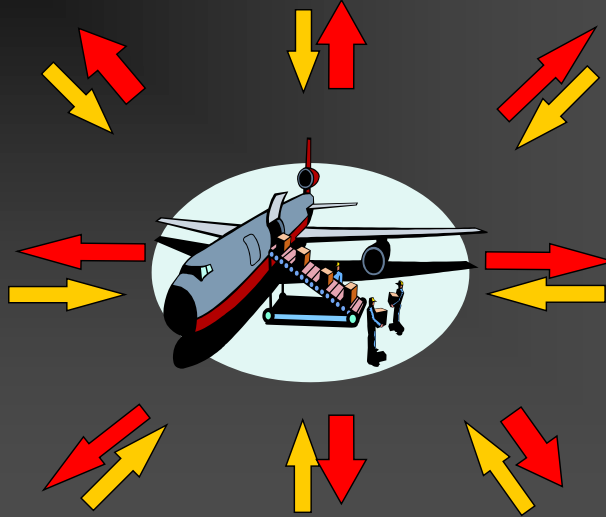
**Restrictions/Limitations** Black and White film used to be a standard 20 years ago because of its clarity, but color film quality is now as good or better than B&W film, the cost of color film is much cheaper (especially considering development), and with color film the investigation team can easily tell the difference between hydraulic fluid, oil, coffee or blood. Commercial developing is probably your only option (unless you have a photo lab). Care should be taken to avoid unauthorized duplication of “sensational” photographs from the accident site.

**Cameras** **35 mm cameras** provide the best quality, various lenses and flash options are available, and the film is inexpensive and can be developed easily. **Instant cameras** are almost useless for investigations. They can provide a quick accident scene picture that can be sent back to team and organizational leaders. Otherwise, the clarity of an instant photograph is extremely poor. **Digital cameras** are extremely handy, but there are a few problems with them. They normally do not have options on lenses (making close shots of broken parts nearly impossible because the camera focuses on the entire background), most printers do not have the clarity of the camera so that the final printed photo is never as clear as a photograph, and the photos can be easily altered with any computer making them a possible liability should the photos ever be used to support a legal matter. **Videos** of the accident occurrence are invaluable, but accident videos are normally only acquired if taken by a passerby who is already operating a video camera. Using a video after an accident (to document the site) will ensure that coverage is more complete, but the quality of individual frames is poor, so additional camera shots are still needed for clarity.

**Security Cameras/Other Sources** It is important to search for photographs of the accident itself. Security cameras, witness videos, or media footage are often available.

**To summarize, a standard 35mm camera is the camera of choice. However, since all other cameras still have some advantages, use every camera that you have. The more photos...the better. Film is inexpensive also, especially compared to “losing” your evidence forever.**

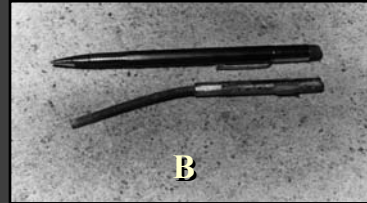
## Eight Compass Point Technique



Aircraft, Equipment and Accident sites should be photographed from all angles. The eight compass points provide sufficient coverage and offer the benefit of documenting total damage. Equipment and wreckage from accidents are often damaged during removal from an accident area or during prolonged storage. Photographic coverage of the accident items “as found” has saved accident boards countless hours by avoiding unnecessary analysis of “new” damages made during recovery/salvage.

(Click Mouse) Remember to also turn around and take pictures outward from the accident site to document the location of external hazards, other equipment, obstacles, ground scars (tire marks, burned areas, wreckage distribution), safety equipment location (including signs, lights, traffic markings/lines, etc.) and locations where witnesses were located when they viewed the accident.

## Useful Photography Hints



### Useful hints:

**Photo A** is a “staged” photograph. The FOD (foreign object damage) piece is held next to the impact mark on the fan blade to show the investigation team’s analysis of what they believed caused the impact mark. The photograph alone is not absolute proof of the damage cause, but it is a useful method to explain a theory. (Use this photo along with a tear down report, location of where the FOD was found, maintenance/operations prior to accident, and possibly even metallurgical analysis to show the transfer of metals between the parts).

**Photo B** shows the size of the tool by its relative size to the mechanical pencil. Using rulers, dice, coins, tape measures, people, hands, or any other object are useful for comparison. This type of size comparison photo does NOT imply that the component was a factor in the accident or reveal any other investigation team analysis.

**Photo C** does show analysis of the investigation team when they compared a normal thermocouple with a fouled thermocouple.

## Always Use a Flash



### **ALWAYS USE A FLASH!**

Use a flash for all photographs...even in bright daylight to illuminate areas that may be shaded.

# Wreckage Diagrams

## ➤ Working Tool

## ➤ Why Do One?

- Do You Have All The Parts?
- Controlled/Uncontrolled Damage?
- Document environment scars

## ➤ Types of Diagrams

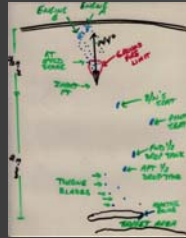
A- Rough

B- Polar

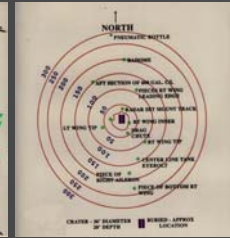
C- Linear

D- Grid

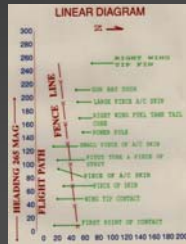
- Other?



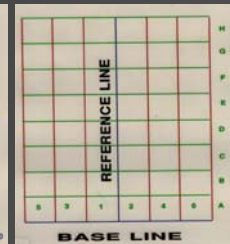
A



B



C



D

The site diagram is a **working tool** for your investigation. Diagrams should be made as soon as possible to be useful to the board. Surveyor diagrams are more accurate and of higher quality, but are a waste of effort and money if they are not completed for days after you have already completed your analysis.

**Why do one?** Diagrams help to ensure that all parts are recovered (or at least noticed missing), show accident paths, are useful for analyzing accident forces, provide documentation of damages, and provide quicker identification of “other” factors through prompt identification of parts/scars.

**Types:** Diagrams can be (rough) sketches, they can be measured outward from a central point (polar) like spokes on a wheel, they can be (linear) motion path sketches with parts measured from either side of the path, or (grid) diagrams where an area of thick vegetation/obstacles can be sectioned using lines or tape with parts labeled per section. Other methods include plastic overlays on overhead photos, photocopied building/floor plans, or maps with markings added, etc. Use your imagination, but ensure that the product can be completed quickly and accurately enough for your use.



# Witness Interviews

## RULES TO LIVE BY:

- One on One Interviews
- Never Interrupt
- Pencil & Paper – AVOID!



Witness statements, like photography, must be gathered quickly and effectively to preserve evidence (before memories fade). Ask witnesses to allow use of tape recorders during the interview and have them review the transcribed statements for accuracy. Statements need not be verbatim in a safety report. Highlights and summaries may satisfy your investigative requirements. For example, a witness may only be able to offer the time of day that he “heard an explosion”...there is no reason to type a four page report describing what he ate for breakfast, what he was thinking about, etc.

### **Rules To Live By:**

One on one: One interviewer to one witness. Multiple interviewers may make the witness feel uncomfortable or threatened. NO group interviews! The most vocal of a group of witnesses will influence others, either directly or indirectly, to agree or not say anything at all. It is better to separate witnesses and compare their accounts later.

Never interrupt: Interruptions will cause the witness to lose their train of thought and crucial information may be missed. Let the witness tell his or her whole story, then ask for clarification later.

### **Pencil and paper:**

(1) Do not pass the witness a paper and pencil and tell them to write down everything they know or think is relevant. No one likes to write, so they will summarize (less information for you).

(2) The interviewer should also use great caution if taking notes or using a form. The interviewer, especially after already talking with other witnesses, may tend to not write anything down unless it is unusual or interesting. The witness may respond by exaggeration and elimination to ensure you keep taking notes (to be helpful??).

**IMPORTANT:** Combining these simple points will make the witness more comfortable. A comfortable witness will approach you a second (or fifth) time if they remember more details or other information. A witness who was uncomfortable with the interview process will never return...even if they have the key to the whole investigation!

# Interview Process

## ➤ Set up the Interview

- Atmosphere
- Non-threatening

## ➤ State the Policy on Use of Safety Report Information

## ➤ Tape Record the Interview



## Start at a Point Prior to the Accident Event

**Set up the Interview** There is no standard location or interview style, however, the goal is to make the interviewer comfortable...not you. Your office may be convenient for you, but it may be poorly lit, noisy, not very private, or too close to the witness' supervisor's office. Use a little common sense and judgment (or simply ask the witness where he/she would prefer to go). The witness may prefer a corner of a dining area, outside on a bench, or a different building.

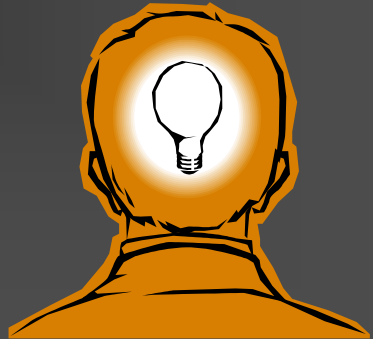
**Policy on Safety** An investigation for safety purposes will attract more witnesses (and more information) than an investigation that is used of punishment of any sort. Most people do not want to get their friends and co-workers in trouble, or be in trouble themselves. If they do seem eager to "punish" someone, there may be a different motive than safety (promotion opportunity?).

**TAPE RECORD THE INTERVIEW!** It is nearly impossible to write everything down that a witness says without either asking for word clarification, missing some lines, or breaking the train of thought of your witness or yourself. Tape recording allows you to really listen to the witness and note their expressions, hand movement, etc. without being distracted by writing. You may also reduce the amount you have to write by only transcribing the important points.

**Start Interviews at a Point Prior to the Accident.** This is common sense, but after your fourth or fifth witness on the same accident, you may try to "save time" by stating, "Tell me everything that you saw after the equipment burned up". You have not asked the witness if they saw the equipment burn or even if they saw a fire...instead, you just TOLD them that the equipment burned and that there was a fire. Do not be surprised if the witness agrees with you (because you're an "expert investigator"). Your entire interview is now flawed and your conclusions will also probably be wrong. In fact, maybe even the first witness you talked to was wrong...the equipment may have been giving off a "normal" amount of smoke/exhaust. Conduct each interview carefully and compare them later.

# Memory Enhancing

- **Recreate the Scene**
- **Focused Retrieval**
  - Help Witness Concentrate
  - Encourage Witness to Talk
  - Bring Up Related Issues
- **Extensive Retrieval**
- **Don't Correct/Interrupt**
- **Language**
  - Customs
  - Don't Talk Down



## **Memory Enhancing:**

**Recreate the scene:** Take them to the location that they were at during the time of the accident or locations that were meaningful to the outcome of the accident (e.g., the calibration lab, the briefing area, the paint booth, etc.). If the accident site is not an option, use a model of the equipment, sketches or photos of the accident areas.

**Focused retrieval:** Allow the witnesses to describe the circumstances (no interruptions) to build a mental picture. When finished, the interviewer may use portions of the statement to clarify details (e.g., determining the time of accident by the related events or getting additional statements on response efforts because you discover the witness not only saw the accident but watched the actions of the fire department personnel).

**Extensive retrieval:** Basically this is the ability to obtain a few more details (or verify the accuracy of previous statements) by conducting multiple interviews with the same person.

**Interruptions/Corrections:** Do not interrupt the witness because it destroys their train of thought. Even if you want clarification of something they just mentioned, it is better to wait until they have finished their entire statement...otherwise, you may clarify one issue while causing the witness to possibly forget to mention two or more issues that were even more important. Corrections also interrupt, but even worse, they may either "lead" the witness or "silence" them because they do not want to be "wrong" again.

**Language:** Use the witness' manner of language and don't correct them. No one likes to feel stupid. For example, if the witness describes a piece of equipment as a "thing, widget, etc.", refer to the component in the same way or just let them continue and ask them to point at the item on the accident equipment, a model, or photo. DO NOT try to impress them with the actual part number, model, or specific terminology. They will be offended and stop talking to you. You just implied that you already know everything about the accident and that they are not sophisticated enough to offer any useful information.

# Talk, Talk, Listen, Talk

- **Talk**
  - Witness Narrates Entire Sequence Uninterrupted
- **Talk**
  - Have Witness Repeat Entire Sequence Again
- **Listen**
  - Listen to Both Sequences
- **Talk**
  - Do You Remember Any Other Details?

“Talk, talk, listen, talk” has been a standard investigation process for years with the U.S. Navy. The concept is simple: Witnesses should be able to state their observations without interruptions. And multiple interviews in one setting offer similar advantages of multiple interviews over a long period of time.

Talk: The witness initially states all that he or she knows concerning the accident. TAPE RECORD this statement (ask permission). DO NOT ASK ANY QUESTIONS UNTIL THE LAST “TALK” because it may influence the statement.

Talk: After a short break, ask the witness to re-record their statement. Ask, beg, complain about needing another copy, or use any rational explanation to do this (time permitting). The witness will probably repeat almost everything they said before, but now that they are more relaxed with the interview process, they may recall more information.

Listen: Offer the witness a coffee or soda and have them listen to their two interview statements. They will probably think of a couple of new details when they realize that their previous answers were not as good as they could be.

Talk: Turn on the tape recorder again and have them record their “new” thoughts or statements. FOLLOWING THIS, YOU MAY NOW ASK QUESTIONS OR SEEK FURTHER INFORMATION. Tape record this final question and answer session

You have just conducted three interviews in a short period of time and provided the witness a great deal of feedback in the process. Multiple interviews have been used by psychologists and police officers for years to stimulate memory and verify the accuracy of previous statements. Unfortunately, their versions are spread over weeks or years. You just accomplished the same thing in one setting.

# Records

**Operations**

**Maintenance**

**Safety**

**Administrative**

**Weather Reports**



Records must be gathered quickly and copied. The purpose of this is to get a document “snapshot” of what was available to decision makers just prior to the accident. Maintenance cards and pubs may be outdated or contain errors. Qualification and training charts may reveal lapses. Schedules often change during the course of the day, so the investigator usually finds more useful information in the scribbled and erased “working copy” compared to the reprinted “what we really did” copy. Administrative documents may reveal issues that affect an individual’s performance....number of consecutive work days, denied sick leave requests, pay records, promotion letters, performance counseling, etc.

These documents will probably not be altered by individuals to hide evidence from the board, but they are likely to be updated routinely over the next few days and important evidence will be lost if the documents are not obtained and copied quickly to get the “snapshot” of current activities.

Let us consider some of these records in more detail...(go to next slide)

# Operational Records



## ➤ Work Schedule

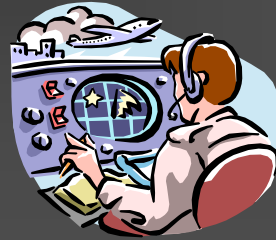
- Working Copy
- Authorized Task
- Test Mission
- Schedule Control
- Logic of Assignment

## ➤ Planning

- Pre-Task Planning & Brief
- Actual operation
- Records, Witnesses, Videos

## ➤ Personnel

- Adequate Training
- Qualifications
- Currency vs Proficiency



Operational reports include those on the slide, as well as many others.

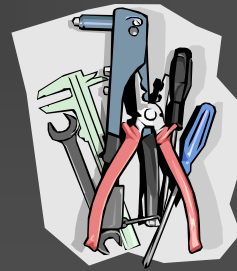
A flight (or other operational) schedule must be reasonably planned and applied. An organization that seems to “react” more than “stick to a plan” will have a working copy of their schedule which is vastly different from the planned schedule. Investigators should compare the two. There is more potential for hazards of confusion, stress, inadequate resources, lack of training, etc. when schedules and plans are ROUTINELY not prepared and followed. An occasional “bad day” without an accident is not unusual, but when an accident occurs during a bad day....one must check the planning and supervision carefully to see if there is a correlation.

Even if the plan is not changed by superiors, personnel may deviate from the plan without the immediate knowledge of the supervisors. It is important to attribute causes to the appropriate sources and causes, or risk having your entire investigation ignored for “obvious failures in analysis”. Video, witness, paperwork trails, etc. of plan implementation will verify whether a plan was followed correctly...and training qualifications, certification, proficiency and currency provide clues to whether the supervisors adequately assigned the right personnel for the task.

**IMPORTANT:** Remember that a person can be “current” (minimum qualification) without being “proficient” (a higher level of skill/confidence). Likewise, a senior operator may be highly proficient (a life-long professional operator), but because they didn’t fill out the paperwork recently, they may not technically be “current”. Do not assume that either currency or proficiency are a factor until verified with other evidence. For example, a new operator who is not trained or current may have done all the procedures correctly, conversely, the current and proficient operator may have made horrible procedural errors for the first time in his life.

# Maintenance Records

- Phase Inspections
- Changes and Modifications
- Inspections
- Gripes/Discrepancies
  - Outstanding & Repeat
- Tool Control



**Copy ALL logs, passdowns, schedules, time cards, maintenance/organizational manuals, SBs, ADs, checklists and policies with “changes”!**

Even if all inspections and maintenance were conducted and documented, were they accomplished correctly? Interviews, training, and analysis of accident equipment will be required to verify it.

Are all maintenance documents updated routinely (a management issue)? Even if most manuals or work cards are updated, was the one used by the maintainer on that particular task updated? Were the manuals available and utilized or was maintenance done by memory, local guidance, or “normal” practices?

Inspections/QA/sign offs...was everything accomplished correctly or was it hurried and/or modified?

Gripes (equipment discrepancies): Was the equipment ready for use, or were there outstanding maintenance/part requirements? Were multiple/repeat repairs of a system sufficient, or is there still a related problem that needs repair? For example: Electrical repairs of radios, wiring harnesses, etc. only fixed the damage that was really caused by a bad generator...after discovering a burned out generator at the accident site, you review the records and find that the generator was never repaired. Interviews with maintenance will be needed to find out WHY it wasn't repaired...were there no symptoms (poor test equipment/technique/procedures), or did no one even test the whole system (training, QA, overworked)?

Tool control: Is there a program? If not, especially with FOD being a major problem, you may be concerned that other maintenance programs are also insufficient. Are misplaced tools always searched for until they are discovered? They should be.

# Safety and Administrative

## ➤ Safety

- Previous accident reports (similarities, clues)
- Databases (trends)
- Prior interventions (successful?)

## ➤ Administrative

- Organizational Planning Documents
- Personnel Issues (awards/reprimands)/Pay
- Work history
- Training

## ➤ Weather Reports



**Safety:** Previous reports and databases are an excellent resource to compare your findings with other similar accidents. For example, if you believe that an accident was caused by a certain system malfunction, check the reports of previous accidents where that system was involved. The reports may reveal that two or three components of that system must fail independently to make the entire system fail. You should then go back to your wreckage and see if those systems failed on your accident equipment. Databases are useful for arguing your theory because you can state that it has happened a number of times previously. Databases are also useful in noting trends (50 tire failures per year) so that changes can be made (buy different tires) BEFORE a major accident happens (with another failed tire). So don't wait for an accident to use or develop a database, use them to prevent accidents. Prior Interventions: If the the previous interventions didn't work, find out WHY...and then try a different approach.

### **Administrative:**

Organizational Planning Documents (restructuring, mergers, business plan)

Personnel issues (previous reprimands or awards); pay (adequate or stressful shortages)

Work history, hiring and layoff dates

Training

**Weather Reports** will reveal environmental factors that could greatly affect the performance of both people and machines. Temperature extremes influence motivation and alter performance. Rain/Snow/Fog can cause slips, reduce visibility and change work requirements. Equipment performance (jet engines, propellers, wings) is reduced in various density altitudes (temp, humidity, altitude combinations). Rain,snow, extreme temperatures can reduce the performance of engines, lighting, brakes, etc.



## Expert Help?

- **Manufacturers**
- **FAA/NTSB**
- **Unions**
- **Aviation/Trade Organizations**
- **OSHA/EPA**
- **Consultants/Contractors**

**Do you need some expert help? This list of experts is hardly all-inclusive, but it does remind you that you are not alone.**

Many organizations are available to assist you in your investigation. Depending on your needs, this could include everything from helpful advice over the phone to joint investigation and lab work.

**Useful Tip:** Assistance from any additional organization will always be better if you show the appropriate concern (i.e. you care – they care). For example, if you mail a part and simply wait for a response, it may be a long wait. Accompany your evidence if possible, and if not, at least maintain liaison with the assisting organization. Showing appropriate concern does not mean trying to rush the analysis process, however.

# Organizing Evidence

- **Acquire ALL Evidence First**  
(wreckage, interviews, records, etc.)



- **Separate/Categorize Evidence for Ease of Management**  
(folders, hangar layouts, documents, data forms, etc.)

- **Methodically Examine and Compare Evidence**  
(specific team duties, meeting times)

## **Organizing Evidence**

We have just discussed many types of evidence and methods of gathering information, but without organization, we may still focus too much on some evidence while completely overlooking others.

A calm, systematic approach is essential to your success. Acquire all evidence first, separate it into manageable “piles”, and methodically work your way through it.

A great deal of investigation team cooperation and integrity is needed to ensure that all evidence is examined appropriately and that “pet agendas” are not included.

# Critical Examination

## ➤ Engines/Machinery

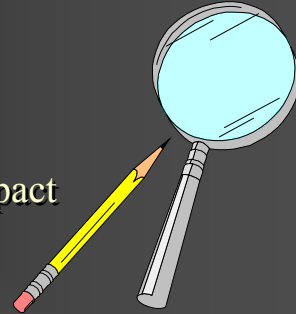
- Were they operable?
- Performance?

## ➤ Equipment/Structures

- Damage caused by failure or impact
- Do you have all of the parts?

## ➤ Fire

- Pre or Post Accident
- Explosion?



**Facilitator:** Quickly mention these categories and refer to the following slides for further details and examples.

Engines/Machinery: Were they operable, and if so, at what performance level? If they were capable of maximum performance, were there other system or operator factors that prevented that performance (operator procedures or training, electrical/fuel system/or other “accessory” failures, control malfunctions such as rigging/binding/disconnections). In other words, check each component and its supporting system components to discover or eliminate accident factors.

Equipment/Structures: Analysis of the bends, fractures, shearing, fatigue, etc. are required to determine whether the damage was the result of the impact or a failure which occurred prior to impact. For example, if the wings broke off in an “upward” direction (relative to the fuselage) when the aircraft hit the ground nose first...the damage would not match. A nose first crash would either break the wings forward toward the nose (after the rest of the aircraft suddenly stopped) or would break towards the tail if the nose continued into the ground but the wings didn’t because they were ripped off by denser soil or rocks. The wings could only have failed “upward” first (inflight breakup), and then the aircraft impacted the ground nose down. The next question is WHY did the wings fail upward? Was their fatigue (design, maintenance problems, or repetitive overstress), were they not designed for normal wear (design), were they over stressed (pilot aerobatics, repetitive previous over stresses, or turbulence), were they wrongly attached during maintenance overhaul (QA, Supervisory, Training), or were they repaired correctly but with “cheaper” replacement parts (supervisory, design)? (**Note:** Again, this process of comparing theories, whys, and failure mode evidence applies to ALL equipment and structures, not just aircraft.)

Fires: A fire is not the cause of an accident, it is the result of another failure (electrical short, hazardous cargo, etc.) or the result of impact (non-crashworthy fuel systems?). YOUR INVESTIGATION IS NOT OVER WHEN YOU DISCOVER EVIDENCE OF FIRE...IT IS JUST BEGINNING! They are numerous design, maintenance, operator, and supervisory factors that explain WHY the fire to occur. Find them!

# Critical Examination

## ➤ Controls

- Continuity of Controls
- Cotter Keys, Safety Wire
- Shear Wire/Pins

## ➤ Survivability/Egress

- Method of Egress Used
- Document Success as Well as Failure

## ➤ Unusual Damage?

Controls should be traced and measured to ensure they operated correctly.

Continuity: Are they rigged correctly? Are there missing components? Do they operate as they were designed (correct direction, deflection, etc.)? Are they rigged correctly but mislabeled so that they were operated in the wrong manner?

Cotter keys and safety wire are just two methods to retain components in their correct position. If they are missing, it must be determined if the tolerances were exceeded which could have led to binding or failed controls. Conversely, if incorrect shear wire or pins were used, then components may not have failed when they should have...leading to greater damage or injury.

### Survivability and Egress

Most operating systems have emergency procedures for securing equipment, minimizing damage, and preventing injury. If there were no procedures, or they were inadequate, there are some supervisory issues that need to be investigated. If the procedures are available, were they followed correctly? Sometimes injury and damage occur when procedures are followed...signifying that the procedures need to be changed. Other times, procedures are ignored with a satisfactory outcome. Close examination of the conditions, procedures, and possible future changes are required to avoid creating a more hazardous condition in the future. An example: If someone didn't wear his seat belt and was thrown from the car before it was engulfed in flames, he was actually better off than he would have been had he been trapped inside with a seat belt. But would you then recommend that no one wore seatbelts? Of course not. Seat belt use saves lives more often than not, so instead focus on the reasons the accident occurred (brakes, intersection visibility restrictions, operator error, etc.) and why they weren't a crashworthy fuel system. Bottom line: keep the seat belts, but remove the crash and/or flame hazards.

### Unusual Damage

Damage that does not seem to match the accident scene can either be pre-existing damage, or be a factor that led to the secondary (and more catastrophic) accident. An example: A crushed rear bumper is not a factor in a normal head on collision, but is a major factor if the car was pushed into oncoming traffic when it was rear ended seconds earlier by a different car.

## Examples of Critical Examinations

A



B



Things don't just break. They break for various reasons. The method of failure can be influenced by impact angles, design flaws, maintenance practices, operator use/misuse, and related component failures. Even something left on a shelf for too long can be damaged by corrosion or component deterioration (seals dry out and crack; normally lubricated areas dry out and bind; etc.)

The slide shows two failures to illustrate the training (or expert assistance) needed to thoroughly understand the complexities of "accidents":

A: Torsional buckling by twisting in opposite directions (in this case, one end of the engine shaft was motionless while the other tried to still rotate).

B: Fatigue. The turbine engine blade root failed after a flaw developed a small crack that progressively worsened over many cycles (fatigue zone) and then failed when there was not enough material remaining to hold the blade (instantaneous zone)

**IMPORTANT:** Do NOT put broken parts back together! The fractured surfaces can be checked with electron microscopes to determine the number of cycles to failure, etc. To prevent any damage to fractured surfaces, wrap each piece separately. Do not clean parts except for (1) salt water/fire fighting agent contamination (clean with water to prevent corrosion of fractured surfaces), or (2) blood-borne pathogen contamination (chlorine/water mix with a 1:10 ratio).

## Critical Examination: TWA 800

Fluid	Flash Point (°F)	Autoignition Temperature (°F)
AvGas (Any grade)	-45	830
JP-4, Jet B	-10	430
JP-5	145	460
JP-7	150	460
Jet A, Jet A1	120	460
JP-8	110	460
Lubricating Oil (Mil-L-7808)	435	730
Hydraulic Fluids		
Mil-H-5606B	195	435
Mil-H-83282	400	625
Skydrol 500 B4	320	945
Hydrazine	126	518

NOTE: Temperatures are approximate and depend on test method and conditions.

### Another Critical Examination Example:

This chart shows the flashpoint and autoignition properties of fuels and oils. The flash point is the temperature at which vapors will form and ignite with a spark...the autoignition temperature is the point at which vapors will ignite without a spark. This chart shows that JET A will ignite easily with a spark at 120 F or warmer, but JP-5 requires a minimum of 145 F. This means that JP-5 is "safer" for storage and use below 145 degrees than Jet A. Note that the autoignition properties are the same for these two fuels...but we are not concerned with "baking" the fuel to the point of spontaneous combustion, we only want to find out when the fuel poses a fire or explosion hazard if an ignition source is available at the same time as the vapors are formed (the "shorted wire theory"). The fuel tank is normally "safe", but the prolonged ground operation of the air conditioner (next to the fuel tank) raised the fuel tank temperature to the point that the Jet A was now able to produce explosive/flammable vapors (above 120F). The "shorted wire" within the center tank (never located by the NTSB) could then provide the spark for ignition. As such, JP-5 was mentioned in the NTSB investigation of TWA 800 as an alternate fuel to reduce the hazard of explosive vapors in the 747's central fuel tank, because the air conditioner was less likely to raise the tank temperature above 145F.

Important: How can fuel burn in an engine (or anywhere else) if it has a flashpoint above 120 degrees and it is only 45 degrees outside? Easy. The fuel-air mixture can be compressed by pistons or compressors (compression raises the temperature above the flashpoint temperature), the fuel is injected into an already burning fire or previously heated section of the engine, or the fuel is vaporized or sprayed. In most engines, all three happen. When you "vaporize" (spray) something, you create a "vapor" without waiting for it to naturally happen by rising temperatures. In other words, you tricked the system! Vaporized fuel will easily burn below the flashpoint because you already created the vapor! That is why fire investigations can become tricky if fuel was sprayed during the course of an accident (inflight breakups, crashes, etc.)

## Additional Damage and Injury



### Additional Damage and Injury

Additional damage and injury may occur in the course of an accident. They add to the human and material “costs” of an accident, but like the survivability issues mentioned earlier, they are not cause factors of the accidents themselves.

Examples: An airplane goes off of the runway in severe weather because of poor braking action, but the property damaged by the aircraft and fire are not causes of the accident, they are the result. Additional fire damage to adjacent property was worse because of the fire department’s slow response. Also, the passengers who were not injured in the initial accident received injuries during evacuation because of poor evacuation slide maintenance, etc.

Another example: An automobile accident victim should have worn seat belts to prevent injuries, but the lack of seat belts had nothing to do with running a red light and hitting another car. Running the light was still only WHAT happened. You should further investigate the accident to find out the WHYS. Was the light operating correctly (maintenance/operation), was it difficult to see (design/planning), was the driver distracted (error), or did the driver just “run the light” (violation). Likewise, investigate the separate issues of survivability and additional damage by determining if the seatbelt was operable (maintenance) or not used (violation). Bottom line: The failure to use the seat belt did not cause this accident, but it did make the accident more costly.

# Human Factors

**System constraints** (organizational structure/limitations)

**Work place attitudes** (safety culture/climate)

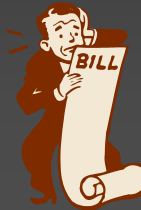
**Supervisory failures** (time, resources, training, policies)

**Environmental factors** (weather, heat, cold, ice, lighting)

**Personal factors** (fatigue, mental stress, ill)

**Errors** (attention/memory, judgment, knowledge, skill)

**Violations** (routine, infraction, exceptional, flagrant)



Human Factors are found in the majority of all accidents. They influence our decision-making abilities and performance to play a major role in causing accidents, or inhibit our abilities to respond to them.

The items listed (on slide) are some examples of human factor concerns that should be investigated following an accident. The list of possible human factors is nearly endless, but they can be categorized into general areas to make your investigation a little easier.

## The NTSB Identified Six Human Performance Profile Factors

(Source: Aircraft Accident Investigation Techniques & Procedures, Human Performance Investigation, TSI, Gerard M. Bruggink, 1985)

- Behavioral (24-72 hr history, on-the-job operator behavior and performance, life habit patterns and events)
- Medical (history, sensory acuity, drug/medication, fatigue/sleep, toxicology)
- Operational Profile (training, experience, operating duties/procedures, company policy)
- Task Profile (task information/content & sources, Task components, task-time relation, task load)
- Equipment Design profile (workspace interface, display/instrument panel design, control design, human engineering/anthropometrics)
- Environmental Profile (external environment, internal environment, illumination, noise/vibration/motion)

Other organizations have made tremendous gains in Human Factors research and classification, as well.

The U.S. Navy, for example, specifically developed the Human Factors Classification System to identify and prevent maintenance human factors aviation accidents (see additional HFACS-ME presentations for more information).



## Preliminary Analysis

### ➤ Analyze Damage

- Contributed to Mishap
- Result of Mishap

### ➤ Develop Scenarios

- Straw man
- Build A Picture
- Timeline



### ➤ Don't Make Evidence Fit Your Analysis!

- You Also Can't Ignore Evidence That Doesn't Fit

#### Preliminary Analysis:

Now that we have accomplished the critical analysis of our separate pieces of evidence, it is time to put the puzzle pieces together in an orderly way, without leaving out pieces or adding ones that don't belong.

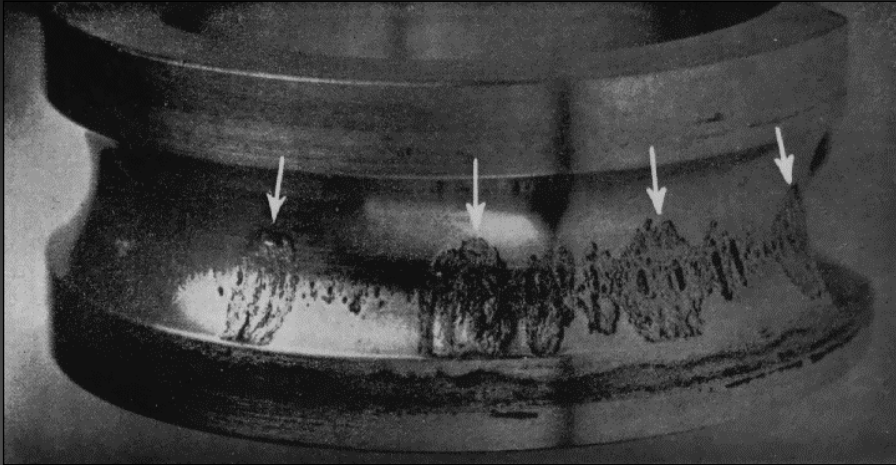
As stated before, accident causal factors must be considered separately from "resultant" factors. Crashes, injuries, death are the results of accidents. Fires are also results of something else (engine failures, electrical shorts). A airplane accident was not caused by the aircraft hitting the ground, it hit the ground because the pilot flew a poor instrument approach. By the way, flying a poor approach is still only WHAT happened. WHY did he fly the poor approach...because he was tired or was he not proficient (hadn't flown instruments in six months...a supervisory issue????).

Use any method that you prefer to develop scenarios. Some investigators use timelines, others use flow charts for the entire accident sequence, some separate factors into before,during, or after accident categories, while others examine factors in relationship to categories of maintenance, operator, supervisor, etc. Again, whatever works for you...it is your investigation.

**WHATEVER YOU DO...DO NOT MAKE EVIDENCE FIT THE ANALYSIS!** It is very easy to focus on a couple of clues and jump to the wrong conclusion. For example, the best maintainer could not make a mistake...it must be an equipment malfunction! Conversely, the weakest mechanic will be blamed...even if he did everything right!!

**EXAMINE ALL EVIDENCE AND BE HONEST IN YOUR APPRAISAL. DO NOT IGNORE EVIDENCE...SOMEHOW, ALL OF IT TIES TOGETHER. FIND OUT HOW...AND WHY!**

## What vs. Why



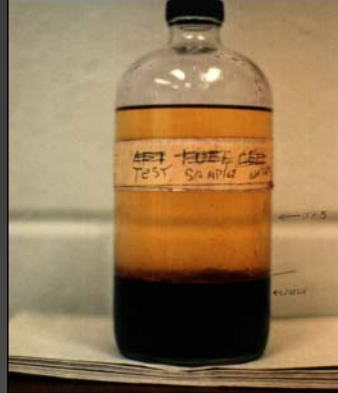
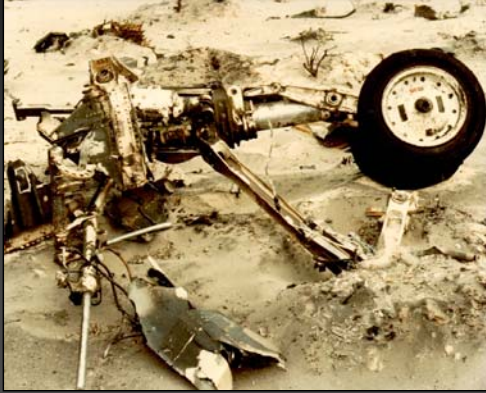
**Here are three extra examples to highlight the analytical process:**

**(1) A Bearing Failure:**

Why did this bearing fail? Many of you will say that it failed due to a condition called spalling or flaking. That is HOW it failed, not WHY it failed.

WHY it failed (spalling) is indicative of either poor manufacturing QA, or contamination/loss of oil during operation, or defects created through rough handling during storage or installation....you get the idea! Many factors could have caused this phenomenon. But don't stop there...WHY was it maintained poorly, or operated incorrectly, not QA'd, or not stored properly? When those answers are discovered, you can recommend specific changes that will prevent future spalling failures (to prevent the same type of accident). Use the additional information you discovered on maintenance/operations/QA to write a hazard report, do risk analysis, or simply make suggestions on OTHER AREAS that need improvement (not part of the accident report). In other words, you are not only investigating accidents, you are also preventing others from ever happening.

## Other System Analysis Examples



Until you discover all the reasons an aircraft crashes, you must thoroughly check all of the aircraft systems (or an organization's "systems").

(2) The **landing gear** in the left picture is not attached to the aircraft. Did it shear off at impact, did the attaching links fail due to fatigue or manufacturing defects, was it improperly maintained, or was it sabotage? Investigators must look at impact marks, separation areas, look for missing parts, and possibly maintenance practices and procedures. In other words, search out and eliminate all possibilities. In this case, the gear was ripped off at impact. But was it fully extended, partially extended, or retracted during the crash? Look at the linkages and doors for impact marks to note the position. What about the operation of the gear? Was it lowered normally (gear handle lowered) or was it "blown down" with a secondary method of gear extension or was it down when the gear handle was up? The latter two conditions could cause pilot preoccupation with the gear during a critical stage of flight and possibly even cause the crash. If it was normally extended, the crash was probably caused by other factors. This is why it is important to document switch positions, photograph and examine the accident parts, and trace their systems out for rigging problems or other maintenance factors.

(3) A third example is the **fuel bottle**. A helicopter crashed in a swamp after a DUAL engine failure. Simultaneous engine failures are not likely unless something happened in common to both...such as pilot inadvertent shutdown of the wrong engine after a single engine failure, fuel contamination, or multiple bird strikes. Fuel contamination is normally checked by sampling tanks, filters, lines, refueling equipment, fuel station supplies, and other aircraft/equipment serviced at nearly the same time. Swamp water immersion would destroy the ability to test the accident aircraft for water contamination prior to the accident, right? Not necessarily. The swamp water was sampled separately from the fuel tank water. The tank water contained chlorine (city water), the swamp water did not. Further investigation revealed that residual city water remained in the tanks following cleaning by maintenance.

## Validation of Findings

### ➤ Has it Happened Before?

- NTSB/FAA/Organization Data Bases
- Technical Representatives
- Corporate Knowledge

### ➤ Research All Possible System Failures



### Validation of Findings

As discussed earlier, investigators must validate their “analysis” by checking and comparing ALL evidence. If you still believe that you have found the “golden BB” (the solution), you can provide further support and validation of your scenario by checking to see if it is actually feasible (contact manufacturers and other experts for material or performance questions) and by seeing if something similar ever happened before (databases, corporate knowledge). Previous failures (databases) do not necessarily prove anything, but the similarities can be compared with your evidence. If they do prove to be similar, you have gained important information...the continuation of a known problem (previously uncorrected) is a supervisory issue in either design, resources, or procedures. Your recommendations will have more influence if you can prove that this is the 27<sup>th</sup> “related” accident, versus only a “freak” type of accident.

Obviously, the most important way to validate your scenario is to double-check all of your evidence. Remember, you may need to have an engineering investigation done on the failures and you might consider re-interviewing your witnesses.

If the scenario you believe happened (based on ALL other evidence) would not have occurred without a particular component failure, ensure that you locate that critical part and have it analyzed...don't assume because you have enough other evidence that “it must have happened that way”....go find out!

# Conclusions

**ONLY Your Accepted Cause Factors of This Accident!**

**(Other hazards, agendas, etc. go elsewhere.)**



**Investigation report “Conclusions” should ONLY contain your accepted cause factors.**

You will normally find many other hazards during the course of the investigation that are not cause factors to the accident. Great! Correct them via other methods, such as hazard reports or maintenance meetings. The accident report is not the place to conclude and recommend solutions to non-factors because it lengthens the report and distracts from the report’s purpose. Also, accident (or hazard) reports should **never** be used for pet projects or other non-factor concerns (e.g. Pilot flight time and benefits are not factors in a forklift accident at an airline.).

**IMPORTANT: Like a good debate, your investigation report’s analysis section must first discuss and eliminate all other reasonable potential factors (not causal) to convince ALL readers that your accepted conclusions (causal) are correct.**

# Recommendations

## IMPORTANT!

- **Recommendations Must Directly Address EACH Cause Factor**
- **Attempt Three Recommendations per Cause Factor** (short/medium/long term fixes)
- **Avoid Generalizations** (review, study, etc.)

### Recommendations

**The Recommendations section of your report is the most important.**

**Why? Because you are trying to prevent future accidents (not just describe this one).**

Recommendations should be specific and address individual cause factors. This is why it is important to discover the WHYS of accidents. Knowing that a mechanic made an error is too vague. You may recommend training, punishment (HOPEFULLY NOT!), or other things which may not have even played a factor. But if you instead conclude that he/she was highly trained, a top employee, but was tired from being overworked for 18 hours, then you can make some reasonable recommendations. These could include mandatory shift hours, scheduling changes, and increased manning levels.

Attempt to identify short, medium, and long term solutions for EACH factor. If you only suggest the expensive, long-term solution it may be implemented too late to prevent a near-term accident...or worse yet, never implemented at all (i.e. too costly/time consuming/complacent)!

Avoid generalizations on recommendations. Reviews, studies, etc. can be “hand waved”.

# Reporting

## Reports Must Be:

- **Thorough** (include accepted and rejected factors)
- **Easy to read/access information**
- **Created and stored in a “standard” format**
- **Timely** (20-30 days is more than long enough)



### Reporting

The reports must be thorough, the format must be easy to read (for immediate use and clarity), and the information should be written in a “standard” format to be useable for database entries.

Reports MUST be completed as quickly as possible, **BEFORE** another accident occurs with any of your accepted factors. Incident reports should only take a few weeks, and accidents should be done in only a month or two. If it takes you several months or a year to finish a report, its usefulness is questionable because many factors (organizational structure, personnel, procedures, publications) were probably updated or modified over that time.

# Trend Analysis



## Trend Analysis

Trend Analysis is extremely important...and many organizations don't do it. Unbelievably, accident reports are sometimes not even acted upon once, let alone reviewed! They are simply filed and forgotten (i.e., just another method of keeping "records", vice using a tool for "accident prevention").

Accident reports and statistics should be reviewed periodically to discover "common" problem areas BEFORE the next accident. REMEMBER, some "common" problems may not be detected, or adequately addressed, in individual accident investigations...but they will become more obvious when comparing all of the reports for trends.

**So, learn something from your previous accidents...spend a little time on Trend Analysis!**

Recommendation: If possible, share your findings with other organizations so that you can learn from each other and BOTH prevent future accidents.



# Equipment Wreckage

## ➤ Preservation

- First 24 Hours

## ➤ Control of Wreckage

- Investigator in Charge or Maintenance?

## ➤ Release of Wreckage

- Request Disposition Instructions
- Chain of Custody



### BY THE WAY.....

**These next two slides have some additional information that organizations should consider when dealing with accidents.**

What happens to the wreckage during, and after, the accident investigation?

We have already stated that the accident site, wreckage, and other evidence needs to be preserved for the investigation, but who is responsible for all of this physical evidence? And how is custody transferred from the original owner/operator/user? Your organization must plan accordingly to eliminate needless confusion and delays during the investigation and recovery efforts. There are also legal implications if custody is not documented well should a case ever be brought to court.

Following an accident, it is recommended that the IIC be responsible for preserving the wreckage, controlling the site, and releasing the wreckage back to maintenance when analysis is complete. Ensure that the transfer paperwork (if required) is in order to eliminate problems/confusion/lawsuits. You don't want to be responsible if someone else loses the parts, puts them back in a different aircraft, sells them, or allows them to become a HAZMAT issue.

# Environmental Concerns

## ➤ OSHA/EPA/HAZMAT Teams

- Advance Liaison
- Develop a Game Plan



## ➤ Accident Plan?

## ➤ Environmental Impact Statement

- EPA Walk Through
- Crash Site Clean-Up
- Organizational Responsibilities



**Even more important...is there adequate concern for environmental hazards?**

Environmental concerns are an enormous problem at an accident site. Contamination must be isolated and cleaned up, often at a huge monetary cost. The accident investigators do not normally conduct this task, but the investigation team and the Investigator in Charge normally have control of the accident site. They are responsible for the evidence and ensuring the coordination of EPA/OSHA/HAZMAT support to prevent further damage.

IMPORTANT! Environmental laws are strict and failure to support them may lead to heavy fines or prison sentences. Organizations must plan ahead for HAZMAT cooperation during accidents. OSHA/EPA/HAZMAT telephone numbers should be included in your Accident Plan and called as soon as possible after an accident. Even if no contamination is discovered, the "bill of health" offered by the inspecting HAZMAT teams provides legal support should a lawsuit ever arise.

## Summary

- **No Pre-Conceived Notions...Let the Evidence Explain the Accident**
- **There is No Single Cause of an Accident**
- **No Two Accidents are Exactly Alike, but They Often Share Similar Hazards**
- **Do not Rely on Any Single Sources of Evidence**
- **VERIFY Your Findings and Conclusions**
- **Accident Reports Should Focus Only on Accident Causes...Not Other Hazards or Issues**

### SUMMARY

Do not arrive at the accident scene with preconceived notions about what happened. You will find ways (or eliminate others) to prove those notions true. Instead, systematically examine all evidence to find the TRUTH.

There is no single cause of an accident. Discover WHAT the other factors are and WHY they occurred.

No two accidents are exactly alike, but they often share similar hazards (hangar lighting, inadequate tools, poor scheduling, etc.). Eliminating the individual hazards will reduce the likelihood of similar accidents.

Do not rely on any single sources of evidence.

VERIFY your findings and conclusions.

Accident reports should focus only on accident causes, other hazards can be addressed elsewhere.

**(Summary continued on next slide)**

## Summary (continued)

- **Recommendations Must Resolve the Accident Cause Factors to Prevent Future Accidents**
- **Recommendations on Non-Factor Issues Will Only Detract From the Accident Report**
- **Short, Medium, and Long-Term Solutions Offer the Greatest Strategy for Accident Prevention**
- **No One Wants an Accident, so Punitive Actions Will Probably Not Prevent Future Accidents**
- **Punitive Actions WILL Limit the Cooperation and Effectiveness of Future Investigations**

### SUMMARY (continued)

Recommendations must resolve the accident cause factors.

Recommendations on non-factor issues will only detract from the report.

Short, medium, and long-term solutions offer the greatest strategy for correction of causal factors.

No one WANTS an accident, so punitive recommendations will rarely prevent future accidents, however, ...

Punitive actions will most certainly limit the effectiveness of future investigations.

# Questions?



## Questions?

**A very thorough investigation is required to not only discover WHY this accident happened, but to also make constructive recommendations to prevent it from happening again...to ANYONE else under SIMILAR circumstances.**

Is your organization capable of this type of accident investigation? Utilizing the basic investigative methods discussed in this presentation, they can perform an adequate investigation...with your help.

**This concludes the Accident Investigation presentation.**

**NTSB photo (<http://www.nts.gov/events/2000/aka261/default.htm>):** Briefing on Alaska Flight 261 “Jackscrew” Hull Loss Accident off Point Mugu, California. Chairman Jim Hall, Dr. Vern Ellingstad (l), and Dr. Bernard Loeb (r) with CVR and FDR from Alaska Airlines flight 261.